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# NAVAL POSTGRADUATE SCHOOL

## Monterey, California



# THESIS

AMBER WAVES OF GRAIN:  
AMERICAN AGRICULTURE  
AS A  
STRATEGIC RESOURCE  
IN A  
CROWDED WORLD

by

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June 1984

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## #20 - ABSTRACT - (CONTINUED)

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Finally, it analyzes the predominant position of the United States in the area of agriculture, relative to both the world in general, and the Soviet Union in particular. Weaknesses are noted and discussed, but the conclusion is drawn that beyond trade alone American agricultural superiority continues to offer important benefits and opportunities and, if handled carefully, may even have strategic implications.

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Amber Waves of Grain:  
American Agriculture  
as a  
Strategic Resource  
in a  
Crowded World

by

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Submitted in partial fulfillment of the  
requirements for the degree of

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ABSTRACT

This thesis deals optimistically with the topic of feeding the increasing world population. It first briefly reviews the literature, favorable and unfavorable, from early thoughts on the subject, past landmark books such as Robert Malthus' On Population and Dennis Meadows' The Limits to Growth to The Global 2000 Report to the President.

In its analysis of the present situation, the paper reviews historical data and current trends. In the area of population, the imaginative, if radical, policies being pursued in China are carefully examined. In agriculture, several developments in the United States are brought out.

Finally, it analyzes the predominant position of the United States in the area of agriculture, relative to both the world in general, and the Soviet Union in particular. Weaknesses are noted and discussed, but the conclusion is drawn that beyond trade alone American agricultural superiority continues to offer important benefits and opportunities and, if handled carefully, may even have strategic implications.

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## I. INTRODUCTION

The year is 2015. The world is embroiled in a desperate struggle for survival. Millions of people have died; thousands more die each day, their gaunt wasted bodies often lie where they fall for days. In the United States and the Soviet Union, domestic order is barely kept. Riots break out sporadically to be quelled by civil authorities only through increasing force. Europe and Japan are barely recognizable as the economic giants of old. The Third World is in anarchy. Armed bands control as much of the territory as national governments.

It is not "the day after" nor "the week after." Nuclear war is not the cause of this widespread suffering. For years, the world had been living on the edge of disaster, agricultural output had just barely been keeping up with rising population. This year marked the third out of four in which harvests in the United States and elsewhere were far below normal. The first year it happened, nearly all stockpiles of food were used to alleviate the problem. Then it happened again, and there were no buffers, no reserves. Starvation spread throughout the Third World; serious shortages occurred in Japan and Europe, as the United States cut exports. The third year, there was a modest recovery, but the United States was the only country with surplus, which was used to

restock domestic reserves, or exported in small amounts to Japan and Europe. The fourth year, this year, had been as bad as the first.

Wheat is selling for five times what it was eight years ago. Adults harken back to the "energy crisis" of the 1970's when oil prices doubled and doubled again. Now oil prices are half their 1990 peak, and grain is a speculation commodity.

The cause is not relevant; severe drought one year, a new fungus the next. It does not matter. There is no one to blame. Also irrelevant is the fact that even the worst of the harvests described produced half again as much food as the record crops at the height of the "Green Revolution." The most important single contributing factor to the situation described is population: the failure of national governments to institute and enforce adequate programs of population control; the failure of developed countries to require such programs as a prerequisite for technological, agricultural and economic aid. Now, as a herd of deer that has overgrazed its habitat, the world population is being thinned by natural process--starvation.

This is a scenario not far from the minds of many experts today: population growth out of control; agricultural output unable to keep up; then disaster. The Global 2000 Report<sup>1</sup>

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<sup>1</sup>Council on Environmental Quality and United States Department of State: The Global 2000 Report to the President, (Washington: U.S. Government Printing Office, 1979).

paints a dark picture, nearly as grim as that depicted here.

Famine - 1975!<sup>2</sup> is also particularly pessimistic. But perhaps it is time to pause and ask as Scrooge did, "Are these the shadows of things that will be, or are they shadows of things that may be?" Beyond that, it is time to re-examine the underlying philosophical assumptions held in approaching the situation. Simply put, is the glass half empty, or half full?

The discussion that follows will examine population and agriculture, two of the most pressing and insidious problems facing the world. Pressing because their resolution must be achieved over the next decade and a half, or the gloomy shadows start to become stark outlines lacking only time to fill in the grim colors of reality. Insidious because they can build quietly while individual nations ignore them or act irresolutely at best until they are nearly insurmountable. Then, they will seem to burst on the scene as a crisis of unimagined proportions. Witness the chaos generated by energy alone in the 1970's, the anger and resentment and sometimes violence aroused in the country by the "gas shortage." Then think what the consequences would be of a similar or greater crisis in agriculture. Think beyond gas lines and magazine photos of hungry children. Think of standing in line for food and regularly not being able to buy what you need, still less what you want.

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<sup>2</sup>William Paddock. Famine 1975! (Boston: Little, Brown, 1967).

If the problem still is not close enough to home imagine the potential conflict. "What if" U.S. harvest falls so short we are unable to meet even minimum requirements agreed to with the Soviet Union. Of course we cut off shipments in order to feed ourselves and our allies, but suppose they started seizing ships transporting grain elsewhere, to Europe for example? "What if" it is not the Soviet Union, but a Third World nation with a nuclear device. Thousands of people are dying there of starvation. Why not threaten New York in exchange for five million tons of wheat? It almost seems reasonable.

There are three other aspects to be considered in further examination of these problems. First is their interrelationship. It is difficult to find in world affairs, two problems that are more closely related than population and agriculture. Population is clearly the independent variable. Were the world to achieve zero population growth in the next five years, the problem and its disastrous potential would disappear. Since that will not happen, it is necessary to understand the close relationship of each of these problems has with the others.

The second aspect is also the most encouraging. These problems have solutions, feasible, socially acceptable solutions. That is the major thrust of this paper. These are not insurmountable hurdles. They are the shadows of things that may be only. The glass is half full.

Finally, and perhaps most importantly, these problems present not only unique and difficult questions for the

United States, but also exceptionally promising opportunities. Today, this country produces, by itself, more than 330 million tons of grain annually.<sup>3</sup> That constitutes proportionally the same control over the world food market as OPEC exercises over the world petroleum market. Together with Australia and Canada, the United States forms a group certainly more homogenous than OPEC which accounts for fully 75 percent of all grain exports in the world.<sup>4</sup> Furthermore, the relatively low population growth of this group ensures that their sway over the world market will only increase as food becomes more scarce. Whatever happens, the United States will be able to feed its people.

The same cannot be said for the Soviet Union. In the trade year which ended June 1983, the Soviet Union imported 46 million tons of grain, more than any country ever had.<sup>5</sup> Nearly half of that total came from the United States. Imports accounted for one quarter of their total grain requirement! If the grain embargo imposed by President Carter

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<sup>3</sup>United States Department of Agriculture, Agricultural Statistics 1982 (Washington, 1982), p. 1.

<sup>4</sup>United Nations, Statistical Yearbook 1981 (New York: United Nations, 1983), p. 15.

<sup>5</sup>Kurt-Eugen Wadekin, "Soviet Agriculture's Dependence on the West," Foreign Affairs 60 (Spring 1982): 6; Also Lester R. Brown, U.S. & Soviet Agriculture: The Shifting Balance of Power, Worldwatch Paper 51 (Washington: Worldwatch Institute, 1982), p. 5.

in response to the Soviet invasion of Afghanistan was ineffective, it was due in part to the surplus existing at the time. There was enough grain available from other sources to make up the difference. In a few years time, that may not be the case. If Soviet dependence on western grain is encouraged and actually increases, they will be in less of a position to reduce or threaten natural gas deliveries to Western Europe. If we and other western nations bargain more acutely and require realistic credit terms, we can offset the hard currency gains the Soviets may make from othersources.

The advantage to be gained could be significant. In the final chapters, this paper will discuss the possibilities presented by the abundance this country takes for granted. To those who protect the manipulation of food as policy, there are two answers. First, the United States does not exist to feed the world. If to a large extent this is the case, as now, it is because the United States is in a position to do so easily. Secondly, consider the alternatives.

## II. HISTORICAL TREATMENTS OF THE SUBJECT

To iterate once again, the object of this paper is not to dismiss out of hand the potential for disaster implicit in these problems. Nor is it to palliate the harsh reality of the situation by claiming that "something will come up, some miracle will occur, some technological breakthrough will be achieved--it always has." But neither will it get caught up in the emotional hue and cry and literacy wringing of hands indulged in elsewhere. Instead, the problem will be looked at from a rationally optimistic or optimistically rational point of view. A mountain climber is constantly aware of the three thousand foot sheer drop below him. Still he climbs. The world faces a similar situation--with no real choice but to go on.

One of the best ways to look at any contemporary situation is to start by looking at the problem as it has been perceived in the past, for that certainly colors the way the future is viewed. It is important to understand what assumptions were made as a basis for past judgments in order to determine whether these assumptions are valid and to what extent changing them affects the outcome, prediction or conclusion.

Agriculture and population have a long historical past. Nearly as long as there have been people, someone has felt that the world was too crowded and that excessive population spelled

impending doom for civilization. Han Fei-Tzu, writing in the fifth century B.C. said:

In ancient times, people were few but wealthy and without strife. People at present think that five sons are not too many, and each son has five sons also....Therefore people are more and wealth is less; they work hard and receive little. The life of a nation depends upon having enough food, not upon the number of people.<sup>6</sup>

Similar sentiments were expressed by Tertullian during the Roman Empire:

The strongest witness is the vast population of the earth to which we are a burden and she can scarcely provide for our needs....<sup>7</sup>

In 1751, Benjamin Franklin foresaw the possibility that population of the United States would double every twenty five years, but it was not a prospect he feared. Instead, he saw that by doubling every twenty five years, in one hundred years the United States would have more Englishmen than England. This would only benefit the country, he concluded:

for...if you have room and subsistence enough...you may make ten nations, equally populous and powerful; or, rather increase the nation tenfold in numbers and strength.<sup>8</sup>

Franklin saw population as national strength, as did many of his contemporaries. He also perceived that the abundance of the North American continent would easily support these people.

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<sup>6</sup> Garrett Hardin, ed., Population Evolution and Birth Control: A Collage of Controversial Ideas (San Francisco: W.H. Freeman and Company, 1969), p. 18.

<sup>7</sup> Ibid.

<sup>8</sup> Ibid., p. 20.

This was the period of the perfectibility of man. The intellectual giants of the age anticipated great strides toward a utopian society based on natural laws governing men similar to those being described that governed nature. Robert Wallace ascribed to these ideas. He anticipated that utopia would be achieved, but that population growth would eventually cause it to fail.

It would be impossible, therefore, to support the great numbers of men that would be raised up under a perfect government; the earth would be overstocked at last, and the greatest admirers of such fanciful schemes most foresee the fatal period when they would come to an end, as they are altogether inconsistent with the limits of that earth in which they must exist.<sup>9</sup>

The excessive population would then have to choose among several extreme alternatives to reduce population. His choices are far more harsh than anyone would dare propose today. They included selective castration at birth, infanticide, and legal age limits beyond which a person would not be allowed to live! Wallace recognized that men would never accept such practices freely:

Force and arms must at last decide their quarrels and the deaths of such as fall in battle, leave sufficient provisions for the survivors, and make room for others to be born.

Thus the tranquility and numerous blessings of the Utopian governments would come to an end; war, and cruel and unnatural customs, be introduced, and a stop put to the increase of mankind, to the advancement of knowledge, and to the culture of the earth in

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<sup>9</sup> Ibid., p. 22.

spite of the most excellent laws and wisest precautions.<sup>10</sup>

Not all agreed with Wallace. William Godwin for one, was directly at odds with those conclusions. In Of Population: An Enquiry Concerning the Power of Increase in the Numbers of Mankind, Godwin concedes that population would continue to grow but would never exceed the limits of subsistence imposed by a finite earth, a situation which in any event was far in the future. Before that, he concluded, man would so perfect himself that he would become essentially immortal, and that Utopian society would eventually produce individuals of such virtuous mind that they would cease to propagate.<sup>11</sup>

It was into this heady intellectual atmosphere that Thomas Robert Malthus injected a dose of sobriety. Writing in response to Godwin and a Frenchman, Jean de Condorcet, Malthus published An Essay on the Principle of Population.<sup>12</sup> The essay drew immediate attention and caused equally immediate controversy, so much so that Malthus spent most of his remaining thirty six years defending and documenting his conclusions. By 1830, he had produced a second edition, a

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<sup>10</sup>Ibid., p. 23.

<sup>11</sup>William Godwin, Of Population: An Enquiry Concerning the Power of Increase in the Numbers of Mankind (London: Longman, Hurst, Rees, Orme, and Brown, 1820; Reprints of Economic Classics ed., New York: Augustus M. Kelly, 1964).

<sup>12</sup>Thomas Robert Malthus, An Essay on the Principle of Population as it Affects the Future Improvement of Society (London, 1798; published as On Population in the Modern Library, New York: Random House, 1960).

book more than twice the length of the original treatise. He had added numerous case studies and further evidence that his conclusions were justified.

Today his ideas are as controversial as ever. Experts fall on both sides of the argument. To be Malthusian is for some to be a sayer of doom, to reject the innate genius of man and accept the inevitability of his demise. For others, Malthus represents a realistic point of view, a warning sign on the road of human development that has been ignored for too long.

Since the book is such a landmark in this field, it deserves closer examination. His ideas seem strong enough at the start. First, and as a basis for all further arguments, Malthus states that, "Population, when unchecked, increases in geometrical ratio. Subsistence increases only in arithmetical ratio. A slight acquaintance with the power of numbers will shew [sic] the immensity of the first power in comparison with the second."<sup>13</sup> Under this assumption even if the earth can produce an infinite amount of food, that production would be so quickly outpaced by population doubling every twenty five years, that in just two centuries there would be 256 times as many people, but only 9 times as much food. There is no limit to either factor, only the assumption that one increases geometrically and the other arithmetically.

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<sup>13</sup>Ibid., p. 9.

Consequently, population must constantly be held in check by some means, but that, "...it is difficult to conceive of any check to population which does not come under the description of some species of misery or vice."<sup>14</sup> As checks to population he included the poor sanitary conditions of towns, war, malnutrition among the poor and discouragements to marriage (by which he meant primarily minimum age limits). Malthus was also opposed to any method of birth control within the sanctity of marriage, on the grounds that it too promoted "misery and vice."

Additionally, regardless of societal checks, population would always increase to the limits of subsistence. If food were abundant, population growth would be rapid; if food were scarce, growth would be slower. There would be times after plagues, wars or after new land is brought under cultivation when most people would have enough to eat and more, but eventually there would be at least as many people as could barely survive.

Since all attempts to limit population result in misery and vice, and since population always expands to the limit of subsistence, man would always be thrown between abundance and bare existence. This theorem was in response to the perfectability of man.

Furthermore, according to Malthus, this problem lay not in the distant future, but was close at hand:

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<sup>14</sup>Ibid., p. 10.

I have read some of the speculations on the perfectibility of man and of society with great pleasure. I have been warmed and delighted with the enchanting picture which they hold forth. I ardently wish for such happy improvements. But I see great, and to my understanding, unconquerable difficulties in the way of them.<sup>15</sup>

Inevitably, regardless of the productive capacity of the earth or the rationality of man, the final limits of the world would be reached well before any natural limits to population were reached, but well after population has expanded beyond the comfortable capacity of the earth.

Malthus drew these conclusions in the early Eighteenth Century, when infant mortality ranged as high as seventy percent, when pestilence and disease beyond the control of man limited population growth to less than one percent annually and when the average life expectancy worldwide was about thirty five years. He could not begin to consider the ramifications of later developments in health care and medicine that cut infant mortality to less than ten percent and extended life expectancy to fifty six years.

The conclusions are valid if the assumptions are acceptable. So far, however, despite the medical developments and health and sanitary improvements of the nineteenth and twentieth centuries, which helped the population growth rate increase to 2.9 percent, Malthus has ended up on the wrong side of the population/production question. Population has

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<sup>15</sup>Ibid., p. 7.

expanded geometrically, doubling about every thirty five years; but through one means or another, agriculture has kept pace. The two most important contributing factors to this result were the failure on Malthus' part, or for that matter, almost everyone's part, to recognize the enormous agricultural potential of North America, and the inability to foresee the extraordinary revolution that has taken place in overall agricultural output, particularly in the last thirty to forty years.

To this point in time, Malthus' basic premise has not been borne out, and though he did not indicate a time limit for his calculations, he implied relatively short term. Since the earth would seem to have an endpoint of production, his conclusions may yet be realized. But their inaccuracy thus far implies a fallacy in simple additive/multiplicative solutions.

More recent Malthusian projections suffer from similar shortcomings, despite the fact that they have expanded beyond the seemingly intuitive assumptions of Malthus. Computer projections and correlation coefficients have replaced simple arithmetic in forecasting doom.

One such projection is The Limits to Growth,<sup>16</sup> a very important work in the field. It has been to recent analysis what Malthus' book was to historical debate. It has stirred

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<sup>16</sup> Dennis Meadows et al., The Limits to Growth (New York: Universe Books, 1972).

discussion and fired controversy. It too has become a label applied to an entire group of experts, usually by other experts who disagree with the conclusions, the assumptions, the methodology, or all three. Complete understanding of the topic requires reasonably careful consideration of The Limits to Growth and its critics.

The book was published at the behest of Aurelio Peccei, founder and president of the Club of Rome. It is the result of work done at the Massachusetts Institute of Technology by Dennis and Donnella Meadows and others. At its base is a concept called systems dynamics, a modelling technique first proposed by Jay Forrester in World Dynamics.<sup>17</sup>

The basic precept of systems dynamics is to be able to combine a variety of factors each of which is constantly subject to change and all of which are closely related. A change in one factor produces a change in one or more of the other factors. The model should be designed to accept the change, produce the appropriate secondary changes and take into account such other factors as time delays, positive and negative feedback loops and other limitations inherent in the real world.

The Limits to Growth assesses the world situation in terms of five basic factors: population, food production, industrialization, pollution, and consumption of non-renewable

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<sup>17</sup> Jay W. Forrester, World Dynamics (Cambridge, Mass.: Wright-Allen Press, 1971).

resources, such as oil and minerals. All five factors are closely related; they clearly affect one another significantly. They also are logically fundamental to economic growth and development.

These five factors expand along exponential growth curves in much the same manner that Malthus predicted geometric growth for population against arithmetic growth for agriculture. Exponential growth occurs when a factor increases by a fixed or growing percentage rather than by a fixed value. The result, of course, is far faster growth. For example, a person with one hundred dollars adding to it at the rate of five dollars per year would double his holding in twenty years. Another person with one hundred dollars adding to it at the rate of 5 percent per year would double his holdings in just fourteen years.

These are simple rules of mathematics, and there is no controversy so far. But, as seen in the discussion of Malthus, the underlying assumptions upon which any model is constructed are at least as important as the model itself. The assumptions are even more important when the model is an ostensibly objective forecast produced by a computer. It is important, though sometimes difficult to remember even today in the midst of the computer explosion, that a computer is a tool, no more and no less. It adds, subtracts, multiplies and divides, correlates, provides regression analysis, and so on at a very rapid rate. It is, however, entirely dependent

on the operator for data and direction. This dependence is often forgotten or ignored. A computer is objective in its output only in so far as the input is objective. No computer exists that will discard or reject information because it is not objective. Judgments of that nature are not part of a computer's ability.

Furthermore, a computer cannot add objectivity. It can only add the aura of objectivity. It is easier, and more dangerous, to view as objective a statement that "the computer projection indicates..." than it is to give the same credence to "After manipulating the data, our conclusions are...". In fact, the statements mean essentially the same thing.

The problem has been summarized as "garbage in, garbage out." This does not mean that the models discussed in The Limits to Growth are garbage, but because of the importance of the underlying assumptions, "Malthus in, Malthus out." If the assumptions upon which the model is predicated are Malthusian in nature, it is much more likely that the conclusions will be Malthusian.

Since the crux of the matter lies in the general attitudes and assumptions which form the foundation for a particular study, it is important to review the model and its projections in this light. This has been done at some length in the case of The Limits to Growth by an equally learned and distinguished group at the University of Sussex, led by Christopher Freeman.

Their results are published in Models of Doom.<sup>18</sup> It is beyond the scope of this paper to conduct as detailed an examination and critique as they have, but it is interesting to review briefly their analysis and conclusions along with those of the MIT group as expressed in The Limits to Growth.

The three most important assumptions inherent in The Limits to Growth are: (1) resources of the world, including non-renewable minerals, agricultural input factors, capacity to absorb pollution, etc., are finite; (2) consumption of these resources is growing exponentially; and (3) human values and technology change too slowly to alter the conclusion apparent from (1) and (2) that there are limits to growth.

The MIT group tested various combinations that included granting mineral reserves extending to 250 years at then current consumption rates, allowing nuclear energy to completely replace petroleum as the primary source of energy and assuming that energy would therefore be inexhaustible, reducing virgin resource requirements by seventy-five percent through recycling and conservation. In other words, they essentially allowed resources to be unlimited. Even under such optimistic conditions, industrialization creates such severe pollution that the world system collapses long before 2100.

Other combinations included the cumulative advantages arising from those allowed previously, plus doubled food

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<sup>18</sup>Christopher Freeman et al., Models of Doom (New York: Universe Books, 1973).

production, "Perfect" birth control (no unwanted children) and reduced rate of pollution to one quarter of 1970 levels. With these seemingly generous advantages, collapse is postponed by twenty to thirty years, but still occurs before the end of the next century.

By contrast, Models of Doom produces equally startling but radically different results. Freeman, et al., criticize the MIT group primarily on two grounds. First, that the assumptions for base level of resources are too low; and second, the rate of change of technology must be allowed to grow exponentially along with other factors.

Included in the first criticism are a wide variety of methodological problems noted by the Sussex group. These problems range from insufficient data to justify long range projections to the use of world averages instead of at least separating the world into developed and underdeveloped countries. The MIT group seems to have foreseen these criticisms, because they apologize for the lack of data, noting that such information has only recently been systematically collected and then only in more developed countries. They also admit that their model, like any other model, is inherently inadequate and imperfect.

However, this did not prevent them from making broad, forceful conclusions such as, "The limits to growth on this planet will be reached in the next one hundred years,"<sup>19</sup>

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<sup>19</sup> Meadows, p. 186.

conclusions made more forceful by the prestige of the members of the group and of the institution they represented.

The second criticism made of The Limits to Growth is more fundamental, as it gets closer to the effect bias and attitudes have on predictive models. Freeman shows that by allowing just a one percent annual growth rate in that technology which applies to each of the five factors, the collapse predicted by the MIT group is postponed almost indefinitely. In fact, Meadows himself concludes in the second revision of the Technical Reports portion of the study, "...It is possible to pick a set of parameters which allow material, capital and population growth to continue through the year 2100..."<sup>20</sup>

In a vein similar to The Limits to Growth, The Global 2000 Report to the President was published in 1979.<sup>21</sup> In fact many of the principals in the MIT-Club of Rome group participated in The Global 2000 Report. The conclusions are, if it is possible, more stark and frightening than those presented in The Limits to Growth. "If present trends continue the world in 2000 will be more crowded, more polluted, less stable ecologically, and more vulnerable to disruption than the world we live in now."<sup>22</sup> By itself that hardly constitutes a great

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<sup>20</sup> Dennis Meadows, et al., Technical Report (New York: Universe Books, 1972), as quoted in Freeman, p. 133.

<sup>21</sup> Council on Environmental Quality and United States Department of State, Global 2000.

<sup>22</sup> Ibid., p. 1.

revelation, but the report is much more specific in several areas, predicting catastrophe almost beyond imagination by as early as 2030.

It is not necessary to discuss in detail the conclusions presented by Global 2000, but it is important to note that as in the case of Malthus and Limits to Growth, Global 2000 has important and expert critics who find fault with its assumptions, methodology, and conclusions. Foremost among them are Professor Julian Simon and the late Herman Kahn.

Characterized as cornucopians by their critics, Simon and Kahn have written extensively regarding the future.<sup>23</sup> Their prognostications which have at least as valid historical backing as those opposing, are positive and optimistic.

It seems clear that, as in most areas, there are at least two sides to the question of world development. The question itself is broad enough to encompass many viewpoints. Therefore, the discussion hereafter will be limited to the population/agriculture interrelationship, venturing afield only as required to address questions relevant to that topic. It will be necessary to review recent data and examine current trends and future possibilities more specifically than has been done heretofore, and the question will be considered largely in isolation in order to assess potential areas of United States' advantage. Finally, conclusions will

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<sup>23</sup> Julian Simon, Global 2000 Revised (Washington: The Heritage Foundation, 1984). See also Herman Kahn, The Coming Boom (New York: Simon & Schuster, 1982).

be drawn and alternative courses of action will be identified that might promote U.S. interests in other areas.

### III. POPULATION

Regardless of whether the world is viewed from the Malthusian, neo-Malthusian, or Cornucopian standpoint, there is little question that one of the most pressing problems in the world today is the ever increasing number of people alive on the planet. As a Malthusian, one assumes that the voracious appetite of the ever-growing mass will eventually consume all the world has to offer and be reduced to destruction and despair. A cornucopian assumes that the world has much more to offer, but that the current high rate of population growth is an anomaly anyway. Both recognize the need to reduce population increase.

Unlike nuclear war, which is controlled by a few educated individuals who understand the possible consequences of such a course of action, the population explosion is controlled by literally billions of people, who fail to recognize that the aggregate of their individual decisions to reproduce may have deleterious consequences nearly as serious in the long run as those associated with nuclear war.

Population growth is a present danger. Its consequences are already clearly visible, and increasing in severity each year. The phenomenal rate of growth of the world population in this century, particularly after World War II, is just that, a phenomenon unprecedented in history. From the time

of Christ until 1900, demographers estimate that the world population grew at an annual rate of somewhat less than one half of one percent.<sup>24</sup> Since 1900 world population has nearly tripled including growing of 2.1 percent annually for the last forty years.<sup>25</sup>

There are many faces to the population problem. There are the faces of the children in the Sahelian whose dull, listless eyes stare out from gaunt, drawn, severely malnourished bodies. There is the face of the new father in China where male heirs are more important than perhaps anywhere in the world, whose wife just delivered their only child, a baby girl. There is the face of the mother in India who has watched her second child in the span of one year die from an infection contracted because of poor sanitary conditions. There is the face of the husband in Latin America whose young wife has just died from complications associated with the birth of their fifth child in six years.

There are also many facets of the population problem. It seems to be made up of several vicious, self-perpetuating cycles any one of which, if broken, would appear to lead to resolution of the problem. One such cycle is that associated with old-age security. A couple in India must have six children, statistically, to ensure a 95 percent probability that

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<sup>24</sup>Kahn, p. 29.

<sup>25</sup>Ibid.

one son will survive to care for them in their last years. If they could be certain of being cared for whether by ensuring the survival of a son from among fewer children through better health care, or by increased government programs for the aging derived from economic development, they would likely have fewer children. But national economic gains are eaten away by 16.6 million new children born in India each year, so neither adequate health care nor old age protection are available.

Another cycle is education. In Peru, women with no education have an average of two more children than women with just six years of education. In Latin America as a whole, women with secondary education have three fewer children than other women.<sup>26</sup> Education reduces fertility by delaying marriage, improving economic well-being, and providing alternatives to being the mother of five and dying young. It also provides knowledge of available birth control measures. But neither the families nor the government can afford to educate all the children, and females are usually the ones who lose out.

Still another cycle is that of birth control information and availability. It can be separated from general education if resources are provided to educate and make available any form of contraception. A survey in Jamaica in 1981 revealed

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<sup>26</sup>United Nations "The States of World Population," UN Monthly Chronicle 77 (July 1982): 82.

that 60 percent of the women interviewed would rather not have had their last child. But resources required for such intensive national programs are not available. The United Nations Fund for Population Activities (UNFPA) has estimated that the fertility rate worldwide would drop by one if women could easily choose not to have any more children.<sup>27</sup>

Although there are many faces and many facets to world population problems, there is only one solution--have fewer children. For many years, the accepted way to accomplish that was through economic development. The overriding theme heard from the Third World at the World Population Conference in Bucharest in 1974 was essentially, "Give us aid and a chance to develop, and the population problem will solve itself."

It has long been evident that economic development and population growth were closely related. Development leads first to faster growth, through better health care and better living standards; it then leads into a phase known as demographic transition where fertility drops and population growth slows. Demographic transition is attributable to breaking the cycles of education, old age security, and so forth. It is also attributable to the fact that in a modern industrial society, children are an economic burden for far longer than in a rural society.

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<sup>27</sup> Ibid., p. 86.

One country that made the transition with remarkable speed and ease in recent years is Japan. During the 1930's, Japan reported birth rates of about thirty per thousand indicating a population growth rate of 1.7 percent.<sup>28</sup> This birth rate remained fairly constant during the war. In the immediate post-war years the birth rate fell off artificially because the national income was only 50-60 percent of pre-war levels, and couples chose not to have children in a period when they could not afford them. A large portion of the decline is associated with illegal abortions, which became so widespread that abortion laws were soon liberalized.

At this point, Japan began undergoing the demographic transition. As the country recovered and the economy grew, the birth rate increased to about thirty four per thousand in 1947-1949, after which it began to fall quite dramatically, to seventeen per thousand by 1959.<sup>29</sup> By 1961, even with significant improvements in the death rate, the population of Japan was growing at only 0.9 percent annually, a rate which has remained fairly constant since then.<sup>30</sup>

Unfortunately, many developing countries made it only half-way through the important demographic transition. They made it only to the point of higher fertility and lower mortality

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<sup>28</sup> Jacki Minoui, "The Baby Boom and After," Japan Quarterly 8 (July-September 1961).

<sup>29</sup> Ibid.

<sup>30</sup> UN, Statistical Yearbook 1980.

rates brought about by modest improvements in health care and sanitation. The result, of course, is unusually rapid population growth which seems to preclude further economic development sufficient to complete the transition.

It is probably fair to say that the primary contributing factor to the current situation in world population growth is the improvement that has occurred in the death rate in the Third World as a result of efforts on the part of the World Health Organization and similar international agencies. This is not a statement apportioning blame. It is simply a matter of fact that widespread inoculations and dissemination of basic rules of sanitation have radically reduced incidents of decimating infections and epidemics. The death toll from formerly contagious and fatal diseases has been cut so severely that the average life expectancy of a child born in Chad today is ten full years longer than it was thirty years ago.<sup>31</sup> Longer life expectancy is indicative of the fact that fewer people have died each year. It is clear that if the additive factor, births, remains constant, while the subtractive factor, deaths, is reduced, the total can only increase, which is precisely what has happened in the world in recent decades.

Take for example the relationship between health care and birth rate. Health care improvements lower mortality in all age groups but these improvements are not immediately

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<sup>31</sup>Ibid.

apparent. Consequently, couples in Lesser Developed Countries continue to produce enough children to offset the infant mortality rate with which they are familiar. If they want four children, they have six to ensure the survival of four. If improved health care reduces infant mortality by 25 percent, the rate of population growth increases by 12 percent in this simple example. This increase results from reduced infant mortality alone. In fact, worldwide infant mortality has been halved in the last thirty years.

However, despite serious problems which still exist in parts of the Third World, the situation is not as bad as experts once predicted. There are signs of hope. The accelerating growth rate reached a peak of 1.99 percent in the 1960-1965 time frame, and has been declining ever since. During the last five years the growth rate has fallen to 1.70 percent.<sup>32</sup> This may not seem significant but its importance becomes clear when the huge number representing the world's current population enters the equation. There are about 4.5 billion people in the world today. A reduction of 1/10 of 1 percent in the rate of growth means 4.5 million fewer people each year. Over time the numbers add up amazingly fast. The UNFPA now estimates that there will be about 6.1 billion people by the year 2000. That is 20 percent fewer than the 7.5 billion there would have been if the population had continued

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<sup>32</sup>Ibid.

to grow at the same rate as during the 1950's. Furthermore, they expect the growth rate to continue to decline reaching about 1.5 percent by the turn of the century. Current estimates call for the world population to continue to grow until about 2025 then actually begin to decline.<sup>33</sup>

Much of the slower growth rate witnessed recently is the result of falling birth rates among developed countries. In 1950, North and South America had approximately the same population. The slower growth rate and falling birth rate experienced in North America since then means that South and Central America now add four times as many people each year. Mexico alone adds more people than Canada and the United States combined.

In Europe, the rate of growth has slowed even more dramatically than in North America. The rate of increase in Western Europe in 1970 was 0.56 percent; in 1975, it was only 0.32 percent. In Eastern Europe, birth rates dropped so low that the governments of Poland and Czechoslovakia adopted pro-natalist policies. In East Germany, the population actually declined from 1975 to 1981. Austria, Belgium, Luxembourg and the United Kingdom have all achieved population stabilization.<sup>34</sup>

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<sup>33</sup>UN, "World Population," Bl.

<sup>34</sup>UN Yearbook 1980: See also Lester R. Brown, World Population Trends: Signs of Hope, Signs of Stress, Worldwatch Paper 8 (Washington: Worldwatch Institute, 1976), pp. 9-13.

This is not to say that there have not been achievements elsewhere. The rate of growth in Cuba has been cut by 47 percent since 1970. Chile, Columbia, Thailand, South Korea and Indonesia have all achieved rate reductions of 15-25 percent. Even India, which still has a rate over 2 percent, has cut that rate by 15 percent in the last ten years.<sup>35</sup>

The most spectacularly successful case of effective, radical family planning has occurred in recent years in the People's Republic of China. China is by far the most populous nation on Earth. During the last decade, the Chinese population grew by 157 million people, a number equal to the combined present population of West Germany, England and France; this despite the First Campaign and the Second Campaign to limit population.

The efforts initiated in the First and Second Campaigns abated during the Great Leap Forward and the Cultural Revolution, but as the political situation following Mao's death stabilized, China's leaders recognized that rapid population growth posed the single biggest threat to the continued development of China.

It became readily apparent that past efforts were inadequate, lacking organization and follow through. Even more recent programs to promote the four person family had failed to stem the tide. China was rapidly approaching a point

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<sup>35</sup> Ibid.

where failure spelled chaos and collapse, because of the long term implications of continued growth. In 1979, the Chinese leadership faced the problem squarely and took resolute, radical action. In light of their apparent success in this difficult area, it is instructive to review the initiatives taken and assess their possible application to other areas of the world.

The Chinese program for population control is a combination of incentives, disincentives, education, availability, persuasion, and according to some, coercion.<sup>36</sup> The most basic goal of population control in China is the achievement of not just stabilization, but actual reduction. The proposed norm in China is the one child family. Chinese couples are encouraged, persuaded, and "mobilized"<sup>37</sup> to limit their offspring to a single child.

Since the current program in China is built on the foundation of the one child family, couples who pledge themselves to only one child receive an "Only Child Glory Certificate."<sup>38</sup>

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<sup>36</sup> Katherine Chiu Lyle, "Planned Birth in Tianjin," China Quarterly 83 (September 1980): 551-563. See also Ashwari Saith, "Economic Incentives for a One Child Family in Rural China," China Quarterly 87 (September 1981): 492-503; and Judith Jacobsen, Promoting Population Stabilization: Incentives for Small Families, Worldwatch Paper 54 (Washington: Worldwatch Institute, 1983), pp. 26-30.

<sup>37</sup> Jacobsen, p. 44 quotes a Chinese birth planning worker as follows: "mobilization is different from persuasion....[We] mobilize the people to do this or that where we fail to persuade them....We hope they understand later."

<sup>38</sup> Pi-Chao Chen, "Eleven Million Chinese Opt for 'One Child Glory Certificate,'" People (a monthly periodical from the International Planned Parenthood Federation), 9:4.

Recognizing that such accolades are valuable but intangible, the Chinese program goes much farther. Upon the birth of the child, the mother immediately receives two extra weeks of paid maternity leave. The parents begin receiving a stipend from the state amounting to one month's combined wages. This stipend continues until the child is fourteen years of age. The parents also receive preferential consideration in applying for jobs with the state outside of the commune, which pay better. The family is given higher priority for larger housing and in some areas, may receive as much as twice the land to build on as a family with more than one child. The parents are rewarded throughout their lives even to the point of receiving a 5 percent bonus in their pensions. (Childless couples receive a 10 percent bonus.<sup>39</sup>)

The child also gains lifelong advantages in addition to those received through his parents. His status as an only child entitles him completely subsidized health care. He also is allowed a full adult food ration from his very first day. An only child is given priority in education and employment in much the same manner as his parents.

The idea, of course, is to make the prospect of a one child family more attractive. The idea is also promoted by making larger families less attractive. The birth of a second child not only revokes and suspends all privileges previously

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<sup>39</sup> Lyle, p. 557. Also Jacobsen, p. 28.

tendered, but also makes the parents liable to pay back all stipends and awards received up to that time. In addition, if a parent received a better job based on the one child family status, that position is immediately forfeited. In certain portions of the country a fine is imposed over and above loss and repayment of stipends. Revenues from these fines are applied toward the only child benefits given to those who remain eligible.<sup>40</sup>

The only child program is encouraged in other ways as well. The government has actively entered the family planning process and birth planning has taken on aspects of other parts of a centrally controlled state. In other areas, quotas are assigned to increase production; in family planning, quotas are assigned in order to reduce it. The State Council Staff Office for Planned Birth, re-established in 1973, assigns quotas to provinces which assigns them to districts, which assigns them to divisions and so on, down to the local subdivision level.

Government family planning workers are an important part of this process. They visit communes, work brigades and factories together with "barefoot doctors" (paramedics), mid-wives and party officials. Birth planning groups are formed so that when quotas are received they are allocated among eligible couples. A couple's eligibility is determined

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<sup>40</sup>Ibid., p. 560. See also Saith, p. 500.

by the group. Newlyweds who have conformed to the delayed marriage guidelines are first, married couples who are childless are second, and couples who have adopted a child or who are handicapped and have only one child are third. (Disabled and handicapped persons are the only ones allowed to have more than one child and they may only have two if they receive an additional quota.)

The family planning workers also act as educators. They provide information regarding contraceptives, abortion, and sterilization. They are also tasked with actively persuading couples to conform to the one child standard.

Couples who are ineligible to have an authorized child or whose name did not make it onto the quota list must take appropriate precautions. Here too, the Chinese government is actively involved. For the childless or one child couple, all contraceptives are free. The government makes available the whole range of mechanical and chemical contraceptives, including the "visiting pill" for couples whose jobs keep them separated most of the time. All operations and procedures related to contraception are also free. This includes insertion and removal of the IUD, sterilization and abortion.

Though preferences vary from region to region and whether the couple resides in the city, the suburbs, or the country, IUD's are the most popular method nationwide. Oral contraceptives are second, and sterilization is third. Sterilization in China most often means tubal ligation, despite its increased

complexity and greater risk compared to a vasectomy. In Tianjin in 1978, for example, 3593 tubal ligations were performed as opposed to only 175 vasectomies. There is a widespread belief in China that vasectomies reduce male strength. There is a one time benefit of about a half-month's wage plus 21 days paid recovery for women and 7 days for men.<sup>41</sup>

Although abortion is not considered a form of birth control in China, the law is very liberal and it is widely practiced. Abortions are free in China, except to unmarried women. For an abortion in the first four months, a woman is granted 15 days work points. After the first four months, 21 days are granted, but due to the ready availability of the operation and the pressure applied to a woman carrying an unauthorized child, abortions after the first four months are rarely required.

The combination of these benefits enables a couple to supplement their income by as much as one third by electing to have only one child. When compared with the payback requirements imposed for having more than one child, the difference is even greater.

The results of this campaign have been extraordinary. The population growth rate in China has plummeted to less than 1.2 percent overall, with some provinces reporting rates as

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<sup>41</sup>Lyle, p. 551.

low as 0.7 percent. But the program is not without its negative aspects. One such aspect is required sterilization. As of 1980, one parent of a family with two children must undergo sterilization.<sup>42</sup> It is difficult to determine to what extent this requirement is being enforced, but similar policy imposed in India during the national emergency declared as a result of food shortages from 1975-1978 caused significant political backlash and contributed to electoral defeat of Indira Ghandi's government at the time, even though the policy in India was never carried out.

Another, more disconcerting aspect of China's one child policy is the continuous flow of reports of infanticide.

Sons have always been very highly regarded in China. In the context of the current policy, male offspring are even more important, with the result that female children have been reported being neglected, abandoned or worse.<sup>43</sup>

A final consideration of China's radical reduction is the long-term implication. If present trends continue, the population of China will stabilize about 2010 at around 1.2 billion. Thereafter, it will decline. In the meantime, the population will undergo a significant aging process of far greater proportions than that which is causing such

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<sup>42</sup> Jacobson, p. 27.

<sup>43</sup> Lijianquo and Zhang Jiaoaying, "Infanticide in China," New York Times, 11 April 1983, Sec. I, p. 25. See also Zing Lin, "Protecting Infant Girls," Beijing Review, 31 January, 1983, p. 4.

difficulty for the United States, Europe and Japan. The problem experienced in the United States in maintaining the viability of Social Security will pale in comparison to the problem China will face.

That, however, is a problem of a different nature which would seem to have far less serious ramifications and more easily attainable solutions than the alternative of allowing uncontrolled population growth. The Chinese have long been the example of a country where population growth was unstoppable. They are disproving that. They are now an example of what resolute, coordinated efforts can accomplish, and as such should be studied by other countries trying to solve a similar problem. The Chinese solution is severe, to say the least, but so is the Chinese problem. Other countries, in reviewing the steps taken in China, can pick those aspects which are less severe, such as incentive and education programs, and tailor them to their own needs.

Fortunately, this is what is happening in several countries in the Third World. Taiwan, South Korea and Pakistan are among those countries who have initiated incentive/disincentive programs, which are beginning to have an effect.

Still, the world's population will continue to grow for some time. If it stabilizes at 10.1 billion, as projected by the United Nations, there will still be more than twice as many people then as there are now. How and what those people will eat is the second part of the question that must now be answered.

#### IV. AGRICULTURE

In light of the enormous growth in population of recent decades, it seems incredible that millions, if not hundreds of millions, do not die each year of starvation, especially during periods of drought and other disasters. It is certainly true that hundreds of millions are hungry and malnourished. Malthus observed that population expands to the limits of subsistence, but with 219,000 people added each day for the last ten years, it seems that the limit of subsistence should have long since been passed. Instead, one reason these people have found at least a bare minimum of food available to them is that the limit of subsistence has been constantly pushed farther and farther back. Just as there are more people alive today than ever before, there is more food available. If it is true that half of all the people who have ever lived are alive today, then it must also be true that half of all the food ever eaten is being consumed today as well.

To the various reasons for population growth already observed must be added another: the internationalization of food. It is closely related to the other reasons because it is based on technology and because it resulted from the global outlook engendered by the expanding web of social and economic ties between and among nations and regions. While it is still true that 89 percent of all food raised is consumed at

or near the point of production, that figure is down from 98 percent just after World War II. The portion of food production that enters international trade is what has made population growth possible by alleviating shortages and famine that would otherwise mean starvation to millions.

Formerly, crop failures or drought were a largely localized problem. They certainly had little effect beyond a particular region, such as the disastrous wheat harvest in France in 1872 which drove up prices throughout Europe. Elsewhere in the world, in the absence of CARE, UNICEF and the like, crop failure led directly to starvation for millions as in India in the late Eighteenth Century or China in 1877 when ten million are reported to have died.<sup>44</sup>

Today, local agricultural shortfalls can be alleviated by massive imports of commercial grain or food aid. This is true only because the food is available elsewhere. To a very large extent, elsewhere means the United States, which accounted for the largest proportion of the world's exported food supply in everything from eggs to eggplant.<sup>45</sup>

In more important basic foodstuffs, the U.S. lead is even more impressive. The United States accounts for more than a

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<sup>44</sup> USDA, Will There be Enough Food: 1981 Yearbook of Agriculture (Washington: USDA, 1981), p. 28.

<sup>45</sup> USDA Agricultural Statistics 1982. The United States accounted for almost 20 percent of all eggs produced, including 257 million dozen exported. The U.S. also produced 21 percent of all the eggplant grown.

third of all wheat exports, half of all corn, and nearly two thirds of all soybean exports. The world as a whole is so reliant on the United States, that when the U.S. harvest is just 10 percent below expectations, food prices in some parts of the world rise as much as 200 percent.<sup>46</sup>

The point right now is not the domination exerted by the United States; rather, the point is how this situation came about, and what it portends for the future. The world's population has been supported by an enormous growth in agricultural production worldwide, the so-called "Green Revolution."<sup>47</sup> Most of the innovations of the Green Revolution trace their roots to advances developed in the United States. In agriculture as in no other field, the world follows where the United States leads.

For many years, agricultural production in the United States expanded as land area settled expanded, from the east coast inland. Little attention was paid to increasing productivity. The growing population of the country was fed by

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<sup>46</sup> USDA, 1981 Yearbook, p. 62. See also Lyle P. Schertz, "World Food Prices and the Poor," Foreign Affairs (April 1974): 513.

<sup>47</sup> The "Green Revolution" began in the early sixties with the development and wide distribution of higher yielding varieties of grain, especially wheat and rice. It produced spectacular gains initially. For example, India doubled wheat production in six years. Some countries such as Mexico briefly exported wheat. But the relentless growth of population eventually caused the situation to revert to one of shortage and insecurity.

bringing more land under tillage. Export products were primarily cotton and tobacco and other plants grown easily here, but not in Europe and which could be or did not need to be cured for the voyage. Foodstuffs constituted a relatively small portion because Europe grew what it needed. A shortage in one country was made up more easily by overland shipments from another country than shipment by sea.

Wheat began to be exported in noteworthy amounts only in the middle of the nineteenth century. By 1865, agricultural exports provided 82 percent of all American exports. Only after 1910 did industry provide more than half of the country's foreign trade.

It was the Industrial Revolution which provided the impetus for improved productivity on American farms. Urbanization and industrialization required more food to be produced by fewer people, as industrial centers attracted farmers away from the land and as cities filled with immigrants. There was land in abundance, but there is a limit to the size of the farm a man and his family can successfully plant, manage and harvest by hand, even with hired help.

Mechanization was the answer. Americans like Obed Hussey and Cyrus McCormick began developing machines to do the work of many men. Plows were developed with multiple blades. Mechanical threshers were built that could harvest more wheat

in less time.<sup>48</sup> At first, these machines were horse drawn, but as early as 1810 an Englishman, Major Pratt, applied a steam engine to a farm tractor.<sup>49</sup>

More and more land was brought into production, while it was worked by relatively fewer people. In the early Nineteenth Century, 85 percent of the U.S. population were farmers. By the 1880's only 44 percent were. Meanwhile, the Homestead Act of 1862 caused huge tracts of public land to be put to the plow.

The United States was perfect for increased mechanization. The vast prairie of the American West encouraged large farms where tractors moved easily and were cost effective. Between 1880 and 1930, agricultural production in the United States doubled. Most of this increased production resulted from utilizing more land; but that was only practical as mechanization increased.

Farm machinery continued to improve, especially with the application of the internal combustion engine, but the next major improvement was the widespread use of fertilizer. Man has long understood the advantages of adding organic matter to soil for improved yield. The practice of planting a field

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<sup>48</sup> Jacob Schmookler, Invention and Economic Growth (Cambridge: Harvard University Press, 1966), App. D. Until 1846, about half of all agricultural inventions were produced by Americans, half by Englishmen. After 1946, Americans generated more than 90 percent.

<sup>49</sup> *Ibid.*, p. 283.

with legumes which fix their own nitrogen and which are then plowed under has been common practice for many years. In 1849, an American firm, Chappel and Davison of Baltimore, Md. developed the process for extracting plant nutrients, particularly nitrogen from organic matter and creating an acceptable, convenient fertilizer.<sup>50</sup> The problem was the cost. It was cheaper to bring more land into production than to apply large amounts of commercial fertilizer. After 1945, however, this was no longer true. Most of the best farmland was already being tilled, and petroleum had become relatively cheap. As a result, from 1945 to 1979 fertilizer use increased eightfold, helping double farm production again between 1930 and 1979.<sup>51</sup>

This was accomplished on less land by fewer people. In 1979, 6 percent fewer acres were harvested than in 1930, and farm population had dropped relatively and absolutely, from about 30 million or 25 percent in 1930 to only 6.2 million or less than 3 percent in 1979. Currently less than 2.3 percent of the American population is engaged in farming.<sup>52</sup>

These changes reflect the influence of technology on agriculture. The land-labor-capital mix of farm production has changed constantly. In 1880, labor accounted for 62

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<sup>50</sup> Encyclopedia Americana, 1964 ed., S.V. "Fertilizer."

<sup>51</sup> USDA, 1981 Yearbook, p. 42.

<sup>52</sup> Ibid., p. 15.

percent of agricultural inputs; land and capital were about 19 percent each. By 1940, labor had dropped to 40 percent, capital had risen to 41 percent. In 1976, only 16 percent of agricultural inputs were attributable to labor. Land input had risen to 22 percent, while capital had soared to 62 percent.<sup>53</sup>

Capital in agriculture is represented in feed, livestock, seed, fertilizer and machinery. It is the last two items which represent both the most important contribution and the most capital. Farm machinery today is bigger, more efficient and more expensive. A man picking corn by hand in 1930 could harvest about 40 bushels or two acres per day. A modern picker can harvest 6500 bushels or 65 acres, and it costs more than \$100,000. A large mid-western farm may have three of them. The cost of fertilizer is affected directly by the cost of petroleum. The low price of oil after World War II encouraged widespread application of fertilizer, and huge crop yields have resulted. But fertilizer prices have risen as precipitously as oil prices in recent years and represent as much as one third of a farmer's capital outlay in a given year.

American agricultural technology is also reflected in the labor to product ratio. In 1880, 100 bushels of corn required 180 manhours. In 1978, only 4 hours were required. Wheat dropped from 373 to just 10 in the same period.

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<sup>53</sup>Ibid.

Poultry production improved 2000 percent between 1940 and 1970.<sup>54</sup>

Furthermore, these advances are related to other gains in productivity. For example, as recently as 1945 it took 14 to 18 weeks and 16 pounds of feed to raise a four pound chicken. It now takes half the time and half the grain--51 days and 8.2 pounds of feed. In 1950, the average dairy cow produced 5314 pounds of milk annually. In 1982, the average annual yield was 12,316 with 20 percent less grain required. Hybrid corn, developed by the painstaking, time-consuming methods of cross pollination, has improved corn yield in the United States from 22 bushels per acre 50 years ago to over 100 bushels per acre currently.<sup>55</sup>

The United States has been responsible for the development of hybrid corn, rust-resistant wheat, and blight resistant potatoes. Developed largely in the land grant colleges sponsored by the Homestead Act, these and other advances are the result of the most extensive agricultural research and development program in the world. In 1981, the United States spent more than one billion on agricultural research. These efforts have produced important results such as a poultry vaccine for Newcastle disease developed at the Virginia Agricultural Experiment Station. The results are economically

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<sup>54</sup> USDA, Agfax--Interesting unpublished items regarding agricultural advances in the possession of the author.

<sup>55</sup> Ibid.

efficient as well, providing a return of 25-50 percent for each research dollar spent. The Newcastle vaccine alone is estimated to save \$1 billion annually worldwide.<sup>56</sup>

Furthermore, U.S. research has not only generated new developments, but also shortened the time span between success in the laboratory and success in the field. Such techniques as plant tissue culturing allow improved varieties to become commercially applicable in 6-7 years.

Nor are American expertise and resources applied only to U.S. agricultural needs. The United States has historically funded 25 percent of the base costs of the Consultive Group on International Agricultural Research, CGIAR, through the Agency for International Development. In 1981, this amounted to \$32 million applied directly to refinement and improvement of rice, dwarf wheat, kasava, etc. CGIAR is particularly involved in improving agricultural production in tropic, arid, and semi-arid regions. CGIAR not only sponsors research, but also promotes education and application of proven methods and techniques.

The United States also serves as the major center for education. With the broad base provided by the land grant colleges, the United States hosts several hundred foreign students each year, many of whom return to their own countries to teach and continue research at national agricultural universities.

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<sup>56</sup>Ibid.

These efforts have paid off well. It is impossible to transfer much of the technology that produces American abundance. An eight row combine would barely be able to turn around on most farms in the Third World. Still, certain aspects have been successful. In Pakistan, the average wheat harvest in the late Seventies was 76 percent bigger than in the early Sixties. The Third World holds the key to feeding the world's increasing population by virtue of the under-utilized agricultural resources available. The Third World has over half of the earth's arable land, which if properly managed and cultivated, could produce far more food than at present. Many of the plant varieties and farming techniques which have successfully doubled and redoubled U.S. production have yet to see widespread use in Lesser Developed Nations.

All of these numbers are somewhat dazzling. They are important and impressive, because they show how the world agricultural production has been able to keep pace with population growth. But they are history. Everyone is modestly acquainted with the world as it is today. The important question is what happens next? Population growth rate has slowed, but there are still more mouths to feed at the end of each day. What discoveries have yet to be made that will feed them and their children?

One of the most important new techniques has to do with the fundamental farming practice of plowing. In earlier years, intensive tillage called for one crop to be planted,

nurtured, and harvested and its residue turned under before a new crop was planted. This allowed farm machinery to move quickly and easily through the fields, but it also encouraged excessive run-off of rain and precious irrigation water which also promoted soil erosion thereby reducing residual pesticide and nutrient amounts. A new practice, minimum tillage, was developed in the early Seventies, necessitated by rising fuel costs. Minimum tillage, or conservation tillage as it has come to be called, encourages the farmer to leave plant residue in the field and to plant the next crop directly through it.

At first, minimum tillage offered only the saving of fuel required for additional cultivation. It caused problems as seeders jammed and planters clogged. But it soon became apparent that minimum tillage offered advantages to offset these problems and stand as a beneficial practice on its own merits.<sup>57</sup>

The most important advantage is a significant reduction in soil erosion. It has been estimated that over the last century, the United States has lost as much as half of its fertile topsoil in some areas;<sup>58</sup> and that rate of deterioration

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<sup>57</sup> Richard & Phillip et al., "No-tillage Agriculture," Science 208: 1108-1113. See also USDA 1981 Yearbook, pp. 65-68.

<sup>58</sup> Council for Agricultural Science and Technology (CAST), Soil Erosion: Its Agricultural, Environmental, and Socio-Economic Implications, Report 92 (Ames, Iowa: CAST, 1982).

was accelerating in recent years under the intensive farming practices used. By leaving plant residue in the field, wind and water take less of a toll. Subsequent crops require less pesticide and fertilizer. They also require less irrigation because the covered soil retains as much as double the moisture of bare soil.

Minimum tillage has also encouraged double cropping since seed can be applied sooner because it is protected by cover from frost. The time saved in not retilling the land allows the second crop to be planted with enough time to mature. In some cases, the second crop is seeded by air while the first crop is still in the field.<sup>59</sup>

Another technique gaining wider acceptance is the use of insects for pest control. Using this method, a population of insects is raised in a laboratory. These insects are irradiated under controlled conditions which renders them sterile but vigorous. The laboratory population is then released into the environment where they mate with insects already present. The next generation simply never develops. This practice has the advantage of avoiding potentially harmful chemical insecticides and of precluding the growth of a population resistant to the particular insecticide applied.<sup>60</sup>

In the area of herd management, scientists are now able to extract a fertilized egg at very early stages, before the

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<sup>59</sup>Phillips et al.

<sup>60</sup>USDA 1981 Yearbook, pp. 125-127.

cells have begun to differentiate. The cells are divided as many as four times producing four identical embryos, which are reimplanted in surrogate mothers. The result is four calves instead of one. Artificial insemination, an experimental technique 10-15 years ago is now widely practiced. It allows fertilization of a particularly productive female with an especially strong male in a process that produces more vigorous offspring in far greater numbers. Embryos for which no surrogate mothers are immediately available can be frozen for future implantation.<sup>61</sup>

Another important success in the area of herd management is a computer link between the ranch and the USDA extension office. The rancher dials the extension office computer and applies his home computer. He then enters his herd size and present feed and silage inventory. The extension computer contains current costs and availability of alternative feeds which it compares with the individual ranchers supplies. It then produces a recommendation regarding how much of each feed to buy for the most effective and productive mix. The optimum feed solution produces better cattle at lower cost in terms of both money and grain requirement.<sup>62</sup>

These are techniques currently available, and gaining wider acceptance. Other techniques will soon become available

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<sup>61</sup> W.R. Gomes, "Emerging Biotechnology in Animal Agriculture," in Agricultural Research Institute (ARI), Emerging Agricultural Technology (Bethesda, Md.: ARI, 1983), p. 5.

<sup>62</sup> USDA 1981 Yearbook, pp. 92-94.

affecting other areas of agriculture. For example, the application of satellite-based infra-red sensing technology has shown promise in crop management. Infra-red imagery can reveal areas of farmland which are excessively dry or show signs of initial insect or fungus infestation. The farmer can then investigate and resolve the problem before it affects a larger portion of his crop. This technique promises to reduce excessive pesticide application and wasteful irrigation or fertilization.<sup>63</sup>

At the edges of agricultural technology are two of the most exciting and potentially productive areas of research, genetic engineering and nitrogen fixation. Scientists have been experimenting with plant genetics since before Luther Burbank and have created more productive and healthier varieties as a result. Their methods were time consuming and arduous, requiring each generation to mature, picking the best plants from among that group, cross pollinating them, and awaiting the result. The discovery of DNA and its role in heredity promised to shorten this process considerably.

The potential is enormous. An average plant uses about two percent of the energy from the sun which reaches it. For each additional percent of sunlight utilized in photosynthesis, the plant doubles its productivity.<sup>64</sup> Genetic

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<sup>63</sup> Ibid., pp. 116-118.

<sup>64</sup> Brian A. Larkins, "Application of Biotechnology to Plant Improvement," in ARI, Emerging Technology, pp. 15-25.

experiments are underway to alter the growth pattern of plant in order to allow more efficient use of sunlight. In another area scientists are attempting to isolate the genes in halophytes, plants which thrive in salt water, in order to introduce that capability into other plants, thereby increasing the amount of land considered arable.<sup>65</sup>

Genetic engineering enters into the second area of note. Man has long recognized that legumes improve the soil by their ability to fix free atmospheric nitrogen. Legumes contain a unique enzyme, nitrogenase, which enable them to do this. Once the process is fully understood and the genetic requirements recognized, scientists will be able to introduce this capability into other plants such as wheat, barley, corn, and sorghum, which presently require significant amounts of expensive commercial fertilizer to provide the necessary nitrogen.<sup>66</sup>

There are just a few of the areas presently under examination which offer the possibility of continued agricultural growth. Certainly a farmer in Bolivia is not likely to have a home computer to use in the near future, but then what farmer in the United States expected to have one, ten years ago. Furthermore, the world has come to rely on the United States for both food production and agricultural technology. Any

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<sup>65</sup> Ibid. See also E.L. Dalley et al., "Recombinant DNA--Food for Thought," Food Technology, July 1981: 26-33.

<sup>66</sup> Ibid.

developments which enhance America's ability to grow more abundant and more nutritious food will improve the U.S. position vis-a-vis the rest of the world in a food crisis, and will buy time so that other advances more appropriate to the Third World can be applied before a food crisis.

## V. THE ROLE OF AMERICAN ABUNDANCE

It seems clear, then, that these problems have solutions. They are solutions which will cost significant amounts of money, and require consistent determination and strength of will. Although they may solve only part of the problem, the prospects are good for averting chaos and disaster which would result from excessive population and widespread famine as described by Malthus, Meadows and others.

The prospect of continued and growing domination of the world food market by the United States is equally good. The United States has the resources and technology to maintain and improve its already enviable position. To accomplish this goal, the country must recognize the potential of this situation in order to take the best course of action to guarantee its position and to take fullest advantage of it.

The influence to be gained relates to the correlation in the United States of the two factors which are most directly applicable; population growth relative to agricultural production. When these factors are combined, the United States has a commanding lead.

It is important to fully appreciate the implications of this leadership role and to better understand both the responsibilities to be shouldered and the advantages that could accrue to the United States from this position. To do

this, it is helpful to consider the strength of the United States compared to the rest of the world, developed, developing and lesser developed countries and most particularly, the Soviet Union.

Even though the anticipated technological advances seem likely to allow agricultural production to keep pace with population growth in the near to middle future, the rapidity with which these advances can be transferred and the degree to which they can be applied to lesser developed countries is limited. Furthermore, while some countries are making strides, or at least small steps, toward population control, world population continues to grow at a rapid pace creating greater pressure on American agricultural resources. Economic development tends to alleviate pressure from that direction by slowing the birth rate, but it tends to increase the pressure from other directions, particularly by creating greater demand for improved diet especially for more animal products.

Agricultural trade throughout the world increased 300 percent in the last two decades.<sup>67</sup> Agricultural trade between the United States and the Third World accounted for a substantial portion of that increase. Driven largely by population growth and economic development in the Third World, the United States exported 115 percent more to Less Developed Country's

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<sup>67</sup> USDA 1981 Yearbook, p. 215.

in 1983 than in 1973.<sup>68</sup> Since population within those countries grew about 23 percent during that time, the proportion of food supplied by the United States increased as well.

Furthermore, the United States' proportion of agricultural aid also increased, both in the areas of direct aid in the form of foodstuffs provided as grants and in the form of agricultural technology. In 1983 the United States gave away more food than the next five donors combined.<sup>69</sup> The 5,464,000 tons of wheat and feedgrains provided by this country represent more food than the combined agricultural output of Central America in this area. The United States also spent \$17.4 million sending teachers, specialists and consultants, in addition to machinery and equipment, to less developed nations.<sup>70</sup> In the middle Sixties, agricultural assistance under the Food for Peace program instituted by President Kennedy amounted to more than 53 percent of all U.S. foreign aid. Current levels have not diminished and still account for more than 30 percent of all foreign aid provided by the United States.<sup>71</sup>

This growth in food aid as well as in agricultural trade, resulted to a great extent from American acceptance of its

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<sup>68</sup> Ibid.

<sup>69</sup> Ibid., p. 247.

<sup>70</sup> USDA, Food for Peace: 1980 Annual Report on Public Law 480 (Washington: USDA, 1980), Table 14.

<sup>71</sup> USDA 1981 Yearbook, p. 242.

post war role as leader of the free world. In shrugging off previous isolationist tendencies, the United States accepted a role theretofore unfamiliar to this country. Part of that role was deemed to be "Breadbasket of the world." The United States recognized the danger inherent in chronic hunger and dislocation. Therefore, the Marshall Plan included massive amounts of direct food aid. Of the approximately \$12.9 billion allocated under the Marshall Plan, \$5.1 billion, or nearly 40 percent took the form of direct food aid.<sup>72</sup>

In 1954, the President and the Congress recognized both the need to transfer growing agricultural surpluses and the potential those surpluses provided. The result was Public Law 480, the Agricultural Trade Development and Assistance Act, which for 30 years has constituted the basic framework for U.S. agricultural assistance programs. The Act, known commonly as PL 480, has been lauded, maligned, condemned and endorsed. It has been restricted, expanded, and amended, but it has remained the fundamental legislation regarding American food aid programs.

Critics of PL 480 have denounced it as manipulative and counterproductive. They point to figures that show the greatest contributions occurring in years of greatest surplus in the United States which tend to correspond with better harvests worldwide and therefore with less need. This allows

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<sup>72</sup> Seymour E. Harris, The European Recovery Program (Cambridge: Harvard University Press, 1948), pp. 168-169.

the United States to gratuitously dispose of its own surplus at the expense of less fortunate farmers in the Third World since it drives prices down, which discourages expansion. In addition, the ready availability of American grain as a supplement in any year serves as a disincentive to national policies to promote production.

Although such criticism was probably valid in the early years of the program, later amendments have stipulated increasingly rigorous application procedures that have gone far toward promoting economic and agricultural development.

There are three sections to PL 480--Titles I, II, and III. Title I programs are those allocations granted on long term, low cost credit and concessional bases. Title I is aimed specifically at promoting economic and agricultural development by alleviating pressure on the local government caused by high food prices and chronic food shortages.

Current requirements for Title I aid call for carefully detailed self-help programs to be submitted with the application. In these proposals, the applicant country outlines policies and actions to be taken to promote agricultural self-sufficiency and economic growth. If certain conditions are met, such as a commitment to use the food directly for wages, repayment of the principle and interest of the loan can be extended or entirely forgiven. Using food aid as wages frees labor from agriculture to be used in developing other areas of the economy, thereby fostering economic growth.

Title II aid is direct assistance to meet urgent needs caused by flood, drought, and other severe but temporary emergencies. It normally takes the form of a grant provided through CARE, Catholic Relief Services or another international organization. For the past two decades, the United States has consistently provided about 60 percent of all the food aid distributed through these channels.

Title III, like Title I, provides aid in the form of a loan designed to meet basic nutritional requirements, promote health services, and encourage population planning. It is specifically targetted toward the world's poorest countries, those with less than \$300 annual per capita income. As under Title I, provisions are made to forgive the loan in its entirety if certain requirements as to its use are met.<sup>73</sup>

Despite the criticism of PL 480, or perhaps because of it and the changes it has brought about, American agricultural assistance programs have shown some important results. Aside from the economic recovery in Japan and Europe fed largely by U.S. assistance, PL 480 programs have made a significant contribution in several other areas, most notably Taiwan and the Republic of Korea. Between 1954 and 1980, these countries received \$394 million and \$1.94 billion, respectively, in food aid from the United States. Of that total, \$65 million was in the form of grants to Taiwan and \$309 million to

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<sup>73</sup>USDA 1981 Yearbook, pp. 238-247.

Korea.<sup>74</sup> The economic expansion encouraged partly by this aid has not brought about agricultural self-sufficiency but has allowed them to feed their people through standard commercial avenues. Korea has not received food grants since 1976, though that country still avails itself of the provisions of Title I. Taiwan has received neither grants nor concessional sales since 1970.<sup>75</sup> Each of these countries continues to rely heavily on the United States for a substantial portion of its agricultural requirements, but these shipments are commercial sales, paid for by means other than low interest U.S. government loans.

Over the years, American agricultural assistance has been subject to many of the same political constraints as other American aid. PL 480 was amended in 1962 to exclude Cuba and again in 1965 to exclude North Viet Nam. In 1966, countries which traded with Cuba and North Viet Nam were excluded from the Food for Peace program, as they had been from other U.S. aid programs. Aid has been withdrawn, as in the case of Cuba and Viet Nam. Aid has been withheld, as in the case of Pakistan and India during their 1967 war.<sup>76</sup>

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<sup>74</sup>United States Bureau of the Census, Statistical Abstract of the United States: 1984, 104th edition (Washington: Bureau of the Census, 1983), p. 674.

<sup>75</sup>Ibid.

<sup>76</sup>Joan M. Nelson, Aid, Influence, and Foreign Policy (New York: Macmillan Company, 1968), p. 16.

While there is no way to ascertain how the world would be different had the United States not embarked on such an ambitious program, it seems likely that the differences would be important. The massive subsidies provided to Cuba and Viet Nam by the Soviet Union, to make up in part for loss of American aid and trade, have diverted funds from other uses, though the Soviets have gained other, less obvious, advantages from those arrangements. Additionally, U.S. food aid has helped stabilize nascent democracies and has quelled turmoil that might otherwise have offered an opportunity for Soviet or Soviet proxy interference.

Critics charge that it has generally masked the problem, and failed in its goal to promote development. Such a charge is difficult to prove or disprove. Agriculture is basic to economic development, but it is only one of many factors. Just as U.S. agricultural assistance is not solely responsible for the economic growth of Taiwan and Korea, it is not solely responsible for the economic stagnation elsewhere. One thing seems certain--there would have been many more deaths worldwide from famine and starvation had the United States not filled the need. But then there would be fewer people to feed now--is famine not natural population control?

It is impossible to credit U.S. agricultural superiority with creating a better world. It is even difficult to point to clear cases where U.S. agricultural pressure was successfully applied to enhance American security. However, there

are instances where food as foreign policy failed dismally. Cuba, India, and Viet Nam come quickly to mind, but two more important cases are the grain embargo of the Soviet Union imposed by President Carter in the wake of the Soviet invasion of Afghanistan, and the partial embargo imposed by President Ford on the Soviet Union in 1975.

The 1975 embargo, or moratorium as it was called, was imposed by President Ford in connection with negotiations to obtain petroleum from the USSR. The objective was not only to establish an alternative to OPEC but to weaken OPEC by forcing the Soviets to commit to a reduced price.

In the spring of 1975, there were indications that the Soviets would again need to purchase substantial amounts of grain as they had in 1972. The massive Russian move into the international grain market and particularly purchases made from the United States were made so secretively that it was called the Great Grain Robbery. Henry Kissinger had become convinced that these purchases indicated a weakness that could be exploited to American advantage. He convinced the President when he reminded Ford that the huge purchases made in 1972 had fueled inflation, a reoccurrence of which the President was eager to avoid.

However, Secretary of Agriculture, Earl Butz, had not been party to the strategems developed by Kissinger, and Butz' assistant, Richard Bell, was actively promoting grain sales. Consequently, when President Ford imposed the moratorium,

partly to prevent inflationary price increases, and partly to apply pressure in the oil negotiations, the United States was already committed to selling ten million tons of grain to the Soviets.

Kissinger and the grain power advocates gained the advantage in July, however, when the International Longshoreman's Union threatened to boycott loading ships with grain bound for the Soviet Union. The union was concerned about rising prices, and about ensuring enforcement of the agreement reached in 1972 that one third of the grain shipped to the Soviet Union would go in American bottoms. To gain labor cooperation in loading the grain already committed, the Ford Administration promised to negotiate a long term agreement with the Russians that would stabilize the erratic influence their massive and irregular purchases had on the grain market.<sup>77</sup>

Discussion of further details of the intra-executive machinations is unnecessary. Kissinger insisted that the agricultural agreement be linked directly to oil concessions. It did not work. The Soviets were unwilling to be seen as either bending under American pressure or as undermining OPEC in any way; nor were they desperate for American grain. For the moment, they were meeting their needs elsewhere. Canada and Australia had ample surpluses to make up the difference, and were more than willing to do so.<sup>78</sup>

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<sup>77</sup> Dan Morgan, Merchants of Grain (New York: Viking Press, 1979), pp. 255-279.

<sup>78</sup> *Ibid.*

Another factor that mitigated against the United States was the control of world grain shipments exercised by the Big Five: Cargill, Continental, Louis Dreyfus, Bunge and Andre. These privately owned, international grain export companies account for over 75 percent of all grain shipments in the world.<sup>79</sup> They are to agriculture what Exxon, Texaco, Getty and the like are to petroleum. While they were unable to ship grain from the United States directly to the Soviet Union, they could easily ship to an Eastern Bloc country for transhipment; or they could divert shipments with other destinations to the Soviet Union and make up the difference with American grain. In 1975, they used both of these methods, and skirted American restrictions with ease.

Furthermore, grain was the only commodity affected by the embargo, which caused significant discontent in the farm states of the American midwest. Their voices grew louder as the summer wore on. When, in September, it finally became apparent that the embargo would have no effect, grain negotiations were concluded and an agreement reached with no link to oil, restrictions were lifted but not before the midwest had become largely disenchanted with Kissinger, and to a lesser extent, President Ford. It is interesting to note that for the 1976 Presidential campaign, Ford chose as his running mate, Senator Robert Dole of Kansas, to offset the illwill caused

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<sup>79</sup> Ibid., p. vii.

by the grain embargo and solidify support in the Republican Midwest which he would otherwise have had little concern over. Had he been able to choose a person more suited to the industrial Northeast, for example, he might have been re-elected.

The lessons of the 1979-1980 grain embargo were not much different from those taught by the 1975 moratorium. The election in 1976 and subsequent change of administration required that they be taught again.

The reasons for the failure in 1979 were much the same as those in 1975. As in 1975, grain was the only commodity restricted. Farmers felt that they were being forced to bear the full cost of President Carter's foreign policy. Although it is true that the restriction applied only to shipments above the eight million ton ceiling agreed to in 1975, the Soviets imported an additional 23 million tons during 1979-1980. Roughly half of that additional requirement would normally have been filled by the United States.

Furthermore, neither Canada nor Australia imposed similar restrictions, though they deplored and publicly denounced Soviet aggression in Afghanistan. Their own grain exports, especially combined with the share they gained from the U.S. restrictions, caused them to put economic self-interest first.

Finally, 1979 was a banner year in agriculture with several nations reporting record or near-record harvests. This enabled Cargil, Andre and company to easily fill Soviet requirements outside of the United States.

The lessons are clear.<sup>80</sup> Although the U.S. supplied one quarter of Soviet grain requirements, it was not the only source available. The flexibility in the world food market, particularly in grain, precluded the United States from achieving any significant aim. The result would probably have been different had Canada and Australia viewed the situation in the same light as the United States. Action by the Soviet Union that is not merely deplorable, but which directly threatens the security of the West, could produce a more concerted effort by the major grain suppliers, in which even the major export companies might join. Such action could in turn cause significant difficulties for the Soviet Union domestically as well as in Eastern Europe.

Clearly recent attempts to apply agricultural pressure to the Soviet Union have not produced the desired or intended results. On the other hand, for the past several years, Soviet agriculture seems to be suffering from a serious malaise. The Kremlin has recognized this situation, but has been unable to alter the results appreciably despite renewed emphasis and application of significant additional resources.

The Virgin Lands program initiated by Nikita Khruschev brought 83 million acres to the plow between 1955 and 1961 but most of that land was of marginal value for intensive agriculture and has since reverted to pasture. The Breznev

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<sup>80</sup> Robert L. Paarlberg, "Lessons of the Grain Embargo," Foreign Affairs 59 (Fall 1980: pp. 144-162. See also Emma Rothschild, "Food Politics," Foreign Affairs 54 (January 1976), pp. 285-307.

era saw an important rise in capital investment devoted to agriculture. The Soviets now expend 27 percent of their total capital investments in agriculture, which amounts to \$50 billion annually.

One of the most important changes in Soviet agriculture has taken place in the last 15 years. Starting around 1969, the Soviet leadership began making an intensive effort to improve the average Russian diet by including more meat. The target of this program was to increase yearly meat production to 185 pounds, about 3/4 of the average American consumption. To do this, the Soviet Union had to abandon the practice of alleviating the effects of a bad harvest by reducing livestock herds, which had created an erratic cycle of huge surpluses in one year followed by widespread shortages for several years thereafter as they attempted to rebuild herd size. This decision to produce more meat more consistently corresponds with Soviet entry into the world food market on a large scale. Their first bad harvest after the program was announced occurred in 1972 and led them to make their first large purchases from the United States.

The program to encourage meat production in the Soviet Union has faltered in recent years, however. After attaining 125 pounds per capita in 1975, meat production has made no further significant gains, despite consistent large imports of high quality feed grain from the West.

In fact, the difficulties experienced in meat production are characteristic of Soviet agriculture across the board.

In six basic agricultural commodities--grain, meat, milk, potatoes, vegetables, fruit, and sugar--the Soviet Union has failed to meet production records set between 1977 and 1979.

An important part of these shortfalls is the nature of the Soviet system, lacking incentives, knotted by bureaucracy, tightly controlled from the center, and frequently mismanaged. But that is only part of the problem since they have managed to achieve significant accomplishments in other areas under the same system.

In truth, a large portion of the blame for the disappointing performance of Soviet agriculture falls on Mother Russia herself, specifically the geographic position of the country and the resultant climate. Only 1/3 of the arable land in the Soviet Union is south of the 49<sup>th</sup> parallel. In the United States, nearly 2/3 of the arable land is south of the 48<sup>th</sup> parallel. This difference is vital to the American ability to produce two crops per year in many areas of the country. The northerly location of the country affects meat production directly as well. With little or no winter protection from the elements, cattle in the Soviet Union use a substantial portion of their feed calories just to keep warm, instead of producing more meat. The difference shows up at the slaughterhouse. An American steer matures to 1100 pounds by the time it goes to market. In the Soviet Union, the average weight of a steer is only 772 pounds.

Another important difference between the two countries is obvious in average rainfall. In the United States, 60

percent of the arable land gets at least 28 inches of rain each year. In the Soviet Union, only 1.1 percent of the arable land gets as much as 28 inches.

The Soviets have other problems related to both the geographic location of the country and the system under which they function. Another aspect of the problem with meat production is the fact that they have not specialized their herds into beef cattle and dairy cows as the West has. In the United States cattle breeding has produced animals which are specifically more efficient for each of those functions. Holstein and Gurnsey are two of the primary dairy breeds in the United States while beef cattle are mostly Black Angus and Shorthorn. Consequently, American ranchers not only get more meat from each herd of cattle, American dairymen get more milk. In the latter case, the difference is an amazing 140 percent. The average cow in Russia produces 5000 pounds of milk each year. In the United States, the average production is over 12,000 pounds; and both milk and meat production in the United States require less feed.

These figures point out a decided weakness within the Soviet economy, one which the Russian leaders do not seem able to rectify. Although past attempts by the United States to exploit that weakness have proven ineffective, the fact remains that the Soviets are increasingly dependent upon feed and grain imports from the West in general and from the United States in particular.

With this historical background in mind, and in light of current trends in population as well as projected advances in agricultural technology, the following questions remain:

"Will current trends allow the U.S. to exercise greater influence? If so--how and when should it be used? If not, what policies should the U.S. adopt to maximize the influence it can exert?"

## VI. CONCLUSIONS

There is no doubt that the United States will continue to play the leading role in world food production for some time to come. There is hardly even a group of countries which if they joined forces, could challenge the American position seriously. Nor is there any doubt that the world will continue to rely on the United States to feed its ever-growing population. Over the last ten or more years, there is not a single case of a country going from a net importer of agricultural products to a net exporter. There are numerous instances of countries which once exported food and which now import food.

This position of leadership carries tremendous responsibilities for the United States. No country has a greater effect on the world food situation than the United States. Nowhere else do policies and practices conducted both domestically and internationally, carry the weight and consequence that they do in the United States. The decisions taken in this country regarding agricultural production and distribution affect the lives of billions of people.

With these considerations clearly in mind, the United States must still act in its own best interests. It cannot long promote a policy or set of policies in agriculture which are detrimental to those interests any more than it can do

so in defense and national security. Therefore, it is time to consider those policies which should be employed, and to what end.

Domestically, the United States must do all it can to encourage efficient production, with due consideration to such encroaching factors as soil erosion, water availability, and other land use requirements. The optimum situation of course is to sell as much as can be produced at the highest possible price. This is no more consistently possible in agriculture than it is in automobile manufacture. Nonetheless, the government began to remove itself from the market in the late Sixties and early Seventies by reducing agricultural price supports. Circumstances in the world food market made this possible and profitable. The result has been erratic and some have called chaotic food prices, but it has also resulted in greater food production and availability.

While favoring reduced subsidies and supports in general, it is important to recognize that for the profit motive to work, a profit must be made. So the United States should promote a modest reserve system and encourage such a system internationally. Reserves are an expensive proposition. To hold 38 million tons of cereal as reserves would cost \$2.5 billion to purchase and \$300 million per year to hold. But properly managed, an international grain reserve system can stabilize prices, encourage production, and provide emergency resources for use in the event of major crop failure and impending famine anywhere in the world.

Furthermore, a national grain reserve makes sense from a security point of view. It is clear that the Russians hold substantial amounts of grain in national reserves. The exact amount is a very closely held secret, but it has been estimated that in 1975, as a result of harvest shortfalls, they drew down nearly 17 million tons of grain to maintain herd size. They would hardly have done so if there were not much more available.

The last important domestic policy which the United States should follow is to continue and encourage expansion of agricultural research and development. Agricultural technology has contributed significantly to the pre-eminent position of the United States in world agriculture, and with most of the best land already being intensively cultivated, the contributions of technology will become even more important.

With regard to the Third World, the role for the United States is complex and challenging. Many developing countries are more dependent on food from the United States than on their own domestic production. This is a situation which the United States must handle carefully. Heavy-handed pressure can have serious ramifications and arouse long lasting resentment, even if successful in the short run or applied toward a beneficial goal.

The two primary goals which the United States should pursue in the Third World are population control and agricultural development. It is absurd to think that the United States

The United States must also assist and encourage the development of agricultural technology relevant to the Third World. Most countries of the Third World have very little capital and relatively more labor, so American agricultural techniques cannot be readily applied. The United States should support regional and local research and development projects which address themselves specifically to the situation as it exists in the Third World. The United States should also impress on local governments the fundamental nature of agriculture in order to achieve greater local support for research. The Third World includes more than half the arable land available, but accounts for less than 11 percent of the funds allocated for agricultural research.

Finally, the United States must develop and pursue a coherent policy with regard to agricultural trade with the Soviet Union. Whereas in the Third World, American policies should be directed toward reducing dependence on the United States, policies directed toward the Soviet Union should do everything possible to encourage dependence. This does not mean selling the Soviets wheat and feed grains at a discount, but it does mean making available as much grain as they want consistent with meeting traditional American commitments to Japan and other allies, and charging them full market price.

In the near term, if it does nothing else, this policy helps drain Soviet hard currency reserves, which would otherwise be available to procure advanced technology. At

the same time, it helps encourage full production of American farmland saving the United States millions in farm subsidies.

In the middle term, the policy encourages the Russians to continue to promote meat production and consumption, which, for them, is relatively inefficient. It also makes the reduction or withdrawal of meat more difficult and politically detrimental which leads to the long term aim of the policy.

The more dependent the Soviets are on the West and particularly the United States for food, the more carefully they must consider the consequences of actions inimicable to Western interests. Although in the past the West has failed to act in concert in this area, the situations in which the question arose did not strike at the core of Western interests. By encouraging dependence and by holding that card closely, the United States can improve its position in certain conceivable situations. The threat of a grain embargo must not be bandied about nor applied without specific intentions. In fact, the less frequently it is mentioned, the more effective it can be.

One important scenario in which it is conceivable that a total grain embargo might be imposed by the United States in concert with Canada, France, and Australia--to great effect--is after a Soviet invasion of Iran in a drive toward the Persian Gulf. Vital Western interests are clearly at stake in such a situation and the threat of losing 25 percent or more of their annual grain requirement would perhaps give the Russians reason to pause at least long enough for the Allies to act.

In sum, American agriculture has long been the backbone of the country. It continues to be a source of strength and influence. America has always been generous in sharing the bounty it derives from its farmland, and there is no reason to be less so in the future. But in an ever more crowded world, the vast natural endowments of this country will be increasingly important in helping to promote stability, prosperity and peace. Second only to the ingenuity of the American people, the abundance of the American land is this country's most important strategic resource.

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